Trends on integrating framework of applications or data

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Finding from the section on Health and Clinical Management

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Summary

Objectives: Summarize current excellent research and trends in the field of Health and Clinical management.

Methods: Synopsis of the articles selected for the IMIA Yearbook 21014

Results: Four papers from international peer-reviewed journals have been selected for the Health and Clinical Management section.

Conclusion: A lot of telemedicine applications are nowadays tested in medical situation, but the challenges underlined through the best papers selection deals on the ability of proposing integrative framework for application or data in order to handle efficiency of health and clinical management.

Keywords: Health and Clinical Management; Patient care management; medical record systems; technologies in healthcare; telemedicine.

Introduction

Health and Clinical Management aims at improving quality, safety and efficiency of health care. The HCM section underlined last year the importance of the introduction of mobile and personalized care related to this topic [1]. E-health is still very important and the literature review for the 2014 yearbook reveals plethora of telemedicine dedicated applications. In order to assume efficiency of health clinical management while taking into account the existence of numerous clinical data as well as numerous clinical applications, nowadays challenges, as underlined by this yearbook topic, are to deal with big data and smart health strategies.. The goal of the Health and Clinical Management section is to provide an overview of the research trends in this area and to propose a “best” paper selection that illustrates these new challenges.

About the paper selection

A comprehensive review of papers published in 2013 has been performed by querying PubMed. 1600 papers were returned by a query built with representative keywords for this section in order to focus on Health and Clinical Management topic. 1079 references were kept, as papers without authors, without abstract or smaller than 4 pages were excluded from the selection. Each section editor

reviewed half of these references and selected the papers which were on the section topic and dealt with medical informatics issues. We chose not to consider a few of them, closer to the Decision Support topic or which were involved in cost-saving issues. 179 references reached the selection criteria. All these references were carefully blind reviewed by both of the two section editors, each of them kept about 30 references. A discussion was performed onto these remaining papers in order to propose 15 papers to international reviewers. Based on the reviews of external reviewers and of section editors, 4 papers were retained as best papers for the HCM section. They are representative of major issues for clinical management.

The Kauppi & al. paper [2] focuses on the construction of benchmark databases and on the elaboration on protocol for medical image analysis. Benchmark databases which propose verified and annotated medical images through expert ground truth could play a major role in developing and evaluating medical image analysis systems. The authors underlined key questions for constructing benchmark databases and aimed at proposing methods and tools to build them in the context of diabetic retinopathy. The Skalkowski & Zielinski paper [3] addresses the problem of processing data from medical personal devices with formalized rules for treatment procedures. Interesting requirements for such systems address the use of large dataset, the processing of the data online or the personalization of the treatment procedures according to the patient. A two-stage process with event processing stage and knowledge application stage is proposed in order to formalize the personal data measurement process. This work is implemented and evaluated in the TeleCare project. The Marceglia & al. paper [4] proposes a methodology for comparing heterogeneous dedicated healthcare systems. Through a review of literature for available e-prescribing systems, they propose a comprehensive model for e-prescription process which allows to represent, compare and analyze the current systems. The model then provides interesting information to design new systems. The Cappozzi & Lanzola paper [5] copes with an interesting area of research for telemedicine system as it proposes a generic infrastructure to support telemonitoring services at home. This infrastructure is able to manage a remote monitoring system integrating different devices such as continuous insulin delivery system and continuous glucose monitoring system in order to simulate an artificial pancreas while simplifying the implementation of telemedicine services; the study is performed in the AP@home project.

Conclusion and outlook

The best papers selected for this section reflect some main challenges in nowadays Health and Clinical Management. The comprehensive review on papers published in 2013 reveals a lot of telemedicine trials. Most of these trials described specific applications often involving a small number of patients; they nevertheless give evidence of an imperious need for distant and cooperative healthcare applications. It is particularly true with chronic diseases which are addressed by a lot of different telemedicine studies. Two main conclusions can be reached from this aspect of the review, on the one hand telemedicine concepts are nowadays easily accepted and on the other hand such tele-applications still deal with heterogeneity and specificity as major issue. Going a step further than proposing telemedicine is then mandatory as shown by the work performed to propose a methodology to compare e-prescription systems [4] or the work made to build integrative telemonitoring system [5].

Future work should also take into account novelty in technology and in engineering models [6] or [7] as it should influence the future researches through new infrastructures. Moreover it helps proposing new devices as u-furniture [8] or artificial pancreas [5].

Another important trend emerging from this review addresses the problem of smart and efficient exploitation of medical data. Two different issues are illustrated by the selected papers: the first one reflects the need of providing useful medical data warehouse as illustrated by the paper on an efficient benchmark database, the second one deals with smart data processing as tackled in the paper on the formalization of rules for treatment procedures.

Nevertheless, the telemedicine aspect for clinical management actually becomes enough important to propose next year a section dedicated to these aspects.

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Appendix: Content Summaries of the Selected Best Papers for the IMIA Yearbook 2014, Section "Health and Clinical Management"

Capozzi D. and Lanzola G. A generic telemedicine infrastructure for monitoring an artificial pancreas trial. Computer methods and programs in biomedicine. 2013; 110:343-53

Continuous Subcutaneous Insulin Injection is used as a safe way to deliver insulin in case of Diabetus Milletus. When added continuous glucose monitoring, a control loop is created: the artificial pancreas. AP@home European project exploits telemedicine infrastructure in order to conduct investigation on the artificial pancreas. Telemedecine can offer continuous monitoring of the patient condition, especially when using nowadays small devices. A functional architecture of the telemedicine infrastructure, inspired by agent notion is proposed. Remote Agents acquire and provide patient information, Clinic Agents interface with the Patient Health Record. Services help to exchange data and are able to address specific tasks varying across context. Generic Remote agent helps to partition the component in 3 categories: services, device independent components and devices dependent components in order to be flexible enough to support different platforms. The telemedicine hub middleware helps to exchange information, syncML is used to encode and represent the data to be exchanged. This infrastructure was used to implement a remote monitoring service. A trial was conduct in order to test the artificial pancreas, which is designed as a remote agent. A web application is defined in order to provide data monitoring and perusal. First trial of the project was made on a PC and further investigation will use Android smart phones.

Kauppi T., kämäräinen J-K., Lensu L., Kalesnykiene V., Sorri I., Uusitalo H. and Kälviäinen Constructing Benchmark Databases and protocols for Medical Image Analysis: Diabetic Retinopathy. Computational and Mathematical Methods in Medicine. 2013; 1-15

The authors address the problem of providing share database of medical images, with verified ground truth and evaluation protocol, medical goal being firstly the automatic detection of diabetic retinopathy. Patient image, ground truth and evaluation protocol are the main components required by benchmarking image databases. Benchmarking framework provides guidelines to construct benchmarking databases. Using key questions related to the usefulness of such benchmark databases, an analysis of the most important public databases in retinal images is performed. Then the following issues are addressed: collecting patient images while respecting patient privacy, annotating images with an annotation tool in order to avoid great disparity of annotation and to support annotation comparison, providing a data format for medical annotation, allowing the fusion of manual segmentation of multiple experts to avoid inconsistency by combining different medical expert advices. An algorithm of evaluation is proposed, with image-based evaluation or pixel-based evaluation, as well as a strawman algorithm. Two image databases with their ground truth are then proposed.

Marceglia S., Mazzola L., Bonacina S., Tarquini P., Donzelli P., Pinciroli F. A comprehensive E-prescribing Model to allow Representing, Comparing, and Analazing Available Systems. Methods Inf Med 2013; 52: 199-219

EPrescribing systems have been widely investigated over the past few years and are now available in most developed countries as part of the healthcare system. The goal of this paper is to provide a deep analysis of existing ePrecribing systems and to define a general model to represent, analyze and compare such systems and design new ones. The literature review has been based on the Pubmed/Medline bibliographic as well as the Google Scholar search engine in order to collect papers on ePrescribing written between 2001 and 2011. Based on this review, the authors defined an ePrescribing model that is composed by two subgroups of actions: the administrative actions and the clinical actions. The administrative actions are the compliance of the system to current laws as well as the right management for the reception or the prescription of a treatment or even the cost analysis. The clinical actions are focused on medical outcomes such as the personal reactions to a treatment. The process is composed of 6 phases: 1) Assign, 2) Transmit, 3) Dispense, 4) Administer, 5) Monitor, 6) Analysis & decision. Based on this 6 phases the authors provide an analysis of the information to be included in the output of each phase documents and their properties. Based on this process and its formal checks, several benefits related to Quality, access and efficiency are listed. Finally in the last part of the paper an evaluation of the ePrescribing model is proposed with three cases studies. Each case study is a comparison between the proposed model and an existing model (i.e. the existing ePrescribing system in the Lombardy region in Italy, the ePrescribing system in the Andalucia region in Spain and in the ePrescribing system deployed in the Italian national regulatory framework). Besides the proposition of a generic model for ePrescribing, an important outcome of this comparison is that the studied ePrescribing systems mainly focus on drug management control. Only one of the three systems provides a clinical support with benefits in terms of quality of care and none of the studied systems provide support for drug administration.

Skalkowski K., Zielinski K.. Applying formalized rules for treatment procedures to data delivered by personal medical devices. Journal of Biomedical Informatics 2013; 46:530-40

Nowadays, more and more personal medical devices (PMD) are available leading to an increase of produced data. This data are very interesting from the medical standpoint but their analysis can be very time consuming for physician. To deal with this issue, this paper presents the TeleCARE framework that proposes the application of formalized rules for medical treatment procedure to PMD's data to enhance patient safety and reduce physician workload. The TeleCARE framework is split in two stages. First is the event processing stage where PMD's data are treated by a Complex Event Processing engine. Second is the knowledge application stage where the processed events are evaluated against a set of rules with the help of a rule engine such as JBoss Drools Expert. These rules have been prepared by several medical experts such as cardiologists and nurses and have to be parameterized individually for every patient. The authors then present an implementation of their framework with an Android application for the gathering of medical data. The overall architecture has been developed with respect to the SOA architecture and relies on REST web services (designed as OSGi bundles) for the carrying of information among the Android application and the two stages of the framework. The TeleCARE system is then evaluated on a group of 20 patients with different illness such as hypertension or obesity for instance but unfortunately the results are not provided in the paper. Instead, the authors focus on the performance evaluation of their solution. Every stage is evaluated independently to see the potential bottleneck of the system. For this evaluation, the number of patients is increased up to 10000 and the result shows that the framework is able to provide results with less than 1s. The number of rules has more impact but nonetheless, the processing time does not exceed 1s for less than 6000 rules. Based on this evaluation, it seems then possible to handle one thousand PMDs with a single instance of TeleCARE.

Capozzi D. and Lanzola G. A generic telemedicine infrastructure for monitoring an artificial pancreas trial. Computer methods and programs in biomedicine. 2013; 110:343-53
Kauppi T., kämäräinen J-K., Lensu L., Kalesnykiene V., Sorri I., Uusitalo H. and Kälviäinen Constructing Benchmark Databases and protocols for Medical Image Analysis: Diabetic Retinopathy. Computational and Mathematical Methods in Medicine. 2013; 1-15
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Skalkowski K., Zielinski K.. Applying formalized rules for treatment procedures to data delivered by personal medical devices. Journal of Biomedical Informatics 2013; 46:530-40

Table1 : best paper selection for Health and Clinical Management section

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